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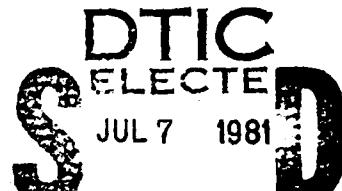
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IDA PAPER P-1584

DIRECTORY OF ORGANIZATIONS,  
INVESTIGATORS, SPONSORS, AND PROGRAMS  
IN RAPID SOLIDIFICATION TECHNOLOGY

T. F. Kearns

May 1981



Prepared for  
Defense Advanced Research Projects Agency

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)  <b>The Institute for Defense Analyses (IDA) was asked by the Defense Advanced Research Projects Agency (DARPA) to make an assessment of rapid solidification technology (RST) and its Department of Defense applications. In doing so, it was appropriate to identify the organizations, investigators, sponsors and programs active in the field in the United States and Canada. Emphasis in the IDA assessment is on (continued)</b>		

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## 20. Continued

materials of construction rather than on electrical or magnetic materials.

The Directory lists 115 organizations active in the field with addresses, names, and telephone numbers of about 250 investigators, and 21 sponsoring organizations. It includes also a listing of topics being studied by the various organizations.

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**IDA PAPER P-1584**

**DIRECTORY OF ORGANIZATIONS,  
INVESTIGATORS, SPONSORS, AND PROGRAMS  
IN RAPID SOLIDIFICATION TECHNOLOGY**

**T. F. Kearns**

**May 1981**



**INSTITUTE FOR DEFENSE ANALYSES  
SCIENCE AND TECHNOLOGY DIVISION  
400 Army-Navy Drive, Arlington, Virginia 22202**

**Contract MDA 903 79 C 0202  
DARPA Assignment A-67**

## FOREWORD

The Institute for Defense Analyses (IDA) was asked by the Defense Advanced Research Projects Agency (DARPA) to make an assessment of rapid solidification technology (RST) and its Department of Defense applications. In doing so, it was appropriate to identify the organizations, investigators, sponsors, and programs active in the field in the United States and Canada. Inasmuch as emphasis in the IDA assessment is on materials of construction rather than on electrical or magnetic materials, that emphasis was reflected in this survey.

The information contained in the directory was compiled by starting with a list of investigators, and their organizations, who had published papers in the field. To these a direct mail questionnaire was sent, requesting information on current activity and future plans, together with identification of others, not on the original list, thought to be active in the field. No attempt was made to identify individual investigators. Organizations were asked only for the names and telephone numbers of appropriate contacts and the topics being studied.

As in any such compilation made over a brief period, there will be omissions, particularly of organizations which may be evaluating RST products. Lack of response to the questionnaire has probably also resulted in omissions. However, we believe that most of the organizations active in RST research and development have been identified. These are listed alphabetically in Section I of the directory with addresses, the names of contacts, telephone numbers, and the topics being investigated.

In Section II, agencies which are, or are likely to be, sponsoring RST research and development are listed, again with addresses, the names of appropriate contacts, and telephone numbers. The "S" following the numbers of agencies in Section II indicates "sponsor" and was used to simplify reference to people in Section III. In Section III contact names are listed alphabetically. It will be noted that several people are listed both as sponsors and as contacts for work being done within their organizations.

We believe that the directory affords an overview of work in progress and that it will help assessment of the distribution of effort, areas of emphasis, possible gaps, and objectives not being effectively pursued. It is being distributed to respondents to the questionnaire and to others with the hope that it may facilitate communications in the field, thus improving efficiency and accelerating the rate of progress in research and development efforts.

SECTION I - ORGANIZATIONS, INVESTIGATORS, AND PROGRAMS

1. Air Force Wright Aeronautical Laboratories

Flight Dynamics Laboratory

Wright Patterson Air Force Base, OH 45433

L.G. Kelly	AFWAL/FIBCB	(513) 255-2521
F.D. Boensch	AFWAL/FIBAA	(513) 255-5006

Programs:

1. Structural concepts evaluation

2. Air Force Wright Aeronautical Laboratories

Materials Laboratory

Wright Patterson, Air Force Base, OH 45433

Dr. H. Burte	(513) 255-5348
Dr. D. Voss	(513) 255-4018
G. Eichelman	(513) 255-4018
Dr. H. Graham	(513) 255-4402

Programs:

1. High-strength aluminum alloy powder metallurgy
2. Titanium/titanium alloy powder metallurgy
3. Superalloy powder metallurgy
4. Aluminides powder metallurgy
5. Coatings

3. Allied Chemical Corporation

Columbia Turnpike, P.O. Box 1021R

Morristown, NJ 07960

Materials Laboratory, Corporate R&D

Dr. Lance A. Davis	(201) 455-2001
--------------------	----------------

Metglas Products

Dr. Nicholas J. Dechristofaro	(201) 455-2976
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Consolidated Metal Products

Julian H. Kushnick	(201) 455-2361
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Dr. J. Dickson	(201) 455-2504
----------------	----------------

Programs:

1. Alloy development of ferromagnetic metallic glasses
2. Process development for fabrication of glassy metal strips
3. Development of technology for fabrication of Metglas distribution transformer material
4. Development of rapid solidification technology for powder production
5. Structure/property relationships in devitrified glassy powders

6. Amorphous ribbon for brazing foils, magnetic and other applications.
  7. Rapidly solidified metal powders for powder metallurgy consolidation into bulk shapes for high temperature, wear-resistant, and structural applications.
4. Alcoa Laboratories  
Alcoa Center, PA 15069  
W.S. Cebulak, Mgr. RSP Alcoa Labs. (412) 337-2324  
H.G. Paris, Tech. Sup. Dev. Act. RSP (412) 337-2751  
F.R. Billman, Tech.Spec. Proc. Dev. RSP (412) 337-2851
1. Elevated-temperature aluminum alloy development
  2. Advanced aluminum alloy from rapidly solidified particulate
  3. Precision aluminum alloy powder metallurgy structural components
  4. Low-cost manufacturing methods for high-strength P/M aluminum wrought products
  5. Fundamentals of compaction processes for rapidly quenched prealloyed metal powders
  6. Cobalt-free high-strength aluminum P/M alloy
5. Ames Laboratory (DOE)  
Iowa State University  
Ames, IA 50011  
R.S. Hansen (512) 294-4446  
C.W. Chen
- Programs:
1. Fabrication of amorphous ribbons (Fe-B-Be and Fe-B-Au) by splat cooling and magnetic properties and crystallization behavior of these ribbons.
6. Argonne National Laboratory  
Materials Science Division  
9700 S. Cass Avenue  
Argonne, IL 60439  
R. Dowagala (312) 972-5094  
T. Wienczek (312) 972-5020
1. The development of corrosion-resistant chromium-free ferrous alloys (a rapid solidification activity will be part of this program)
7. ARMCO INC.  
Research & Technology  
703 Curtis Street  
Middletown, OH 45043  
C.E. Ward (513) 425-2797
- Programs:
1. Evaluate the magnetic properties of amorphous metals (rapidly solidified alloys) for use in transformers

8. U.S. Army Applied Technology Laboratory  
Fort Fustis, VA  
J.M. Lane (804) 878-3977  
Programs:  
1. Evaluation of RST alloys
9. U.S. Army Armament Research and Development Command (ARPARCOM)  
DRDAR-SCM-P Bldg. 355  
Dover, NJ 07801  
Dr. J. Waldman (201) 328-5811  
M. Kumar (201) 328-5816  
Programs:  
1. Characterization of rapidly solidified high-strength aluminum alloys  
2. Thermal-mechanical processing of RST aluminum alloys
10. U.S. Army Armament Research and Development Command  
Metallic Materials Branch Bldg. 355  
Dover, NJ 07801  
Dr. S.J. Cytron (201) 328-5746  
Dr. M. Otooni (201) 328-5746  
Programs:  
1. Rapid solidification technology of armament materials  
2. Processing of rapidly solidified high-density metal alloys  
3. Kinetics of crystallization of rapidly solidified alloys
11. U.S. Army Armament Research and Development Command  
Physical Science Section, Research Branch, Benet  
Weapons Laboratory  
Watervliet Arsenal, Watervliet, NY 12189  
Dr. Iqbal Ahmad (518) 266-5615  
Mr. Joe Barranco (518) 266-5645  
Programs:  
1. Study effect of cooling rate on the structure and properties of molybdenum powders made by REP.  
2. Develop and characterize molybdenum alloy powders suitable for defense applications.  
3. Study kinetics of sintering and densification of RS molybdenum alloy powders, and determine the mechanical behavior of the densified alloys in the temperature range of RT-1200°C.
12. U.S. Army Materials and Mechanics Research Center(AMMRC)  
DRXMR-KA  
Watertown, MA 02172 (617) 923-3504  
S. Isserow  
Programs:  
1. Evaluation of RST alloys

13. U.S. Army Mobility Equipment Research and Development Command (MERADCOM)  
DRDME-FM  
Fort Belvoir, VA 22060  
W.F. McGovern (703) 664-5459  
Programs:  
1. Evaluation of RST superalloys
14. Avco Lycoming Division  
Materials Engineering and Development  
550 S. Main Street  
Stratford, CT 06497  
L.J. Fiedler (203) 378-8211 x229  
Dr. P.J. Bania  
Programs:  
1. Evaluation of high-temperature properties of RST materials
15. Battelle Columbus Laboratories  
505 King Avenue  
Columbus, OH 43201  
Dr. R.S. Carbonara (614) 424-5440  
R.E. Maringer (614) 424-4314  
J.L. McCall (614) 424-4030  
Programs:  
1. Processes for the production of rapidly solidified amorphous and microcrystalline strip, fibers, flakes, and powder  
2. Consolidation of rapidly solidified amorphous and microcrystalline metals  
3. Characterization of structural, corrosion, mechanical, and electromagnetic properties of rapidly solidified materials  
4. Application of rapidly solidified materials to industrial and government needs  
5. Production of superalloy and Ti-, Al-, Cu-, Ni-, Fe-, Zn-, Sn-, Pb-based alloy powders, fibers, flakes and strip  
6. Economic analysis of rapid solidification processes
16. Battelle Pacific Northwest Laboratory  
P.O. Box 999  
Richland, WA 99352  
S.D. Dahlgren (509) 375-0120  
J.T. Prater  
D.P. Baer  
W.T. Pawlewicz  
J.W. Patten  
M.D. Merz

Programs:

1. Oxidation and corrosion resistance of sputter-deposited fine-grained and amorphous metals.
2. Influence of sputtering parameters on structure and behavior of sputter-deposited metallic and insulator materials

17. Bell Telephone Laboratories

Mountain Avenue  
Murray Hill, NJ 07974

- K.A. Jackson (201) 582-4188  
Dr. M.L. Green, Rm. 1B301 (201) 582-5310
1. Basic studies of interface dynamics during rapid solidification
  2. Segregation effects during high-speed crystallization

18. Bethlehem Steel Corporation

Homer Research Labs.  
Bethlehem, PA 18016

- Dr. J.M. Chilton (215) 694-3320  
Dr. B.L. Bramfitt (215) 694-6485  
Dr. H.E. Townsend (215) 694-6674
1. Application of RST to wear-resistant high alloy irons
  2. Application of RST to electrical and magnetic steel sheet
  3. Corrosion of RST metals

19. The Boeing Company

P.O. Box 3707, M/S 73/43  
Seattle, WA 98124

- Dr. Wm. E. Quist (BCAC) (206) 237-5650  
Dr. G. Hari Naranayan (BCAC) (206) 237-5650  
Dr. K. B. Das (BAC) (206) 237-9725
1. Development of high-strength aluminum P/M alloys
  2. High-strength powder metallurgy aluminum mill products
  3. Commercial aircraft applications of X7090 and X7091 P/M alloy forgings and extrusion products
  4. Development of surface finish systems for the P/M alloy X7090
  5. Cobalt-free high-strength aluminum P/M alloy
  6. Development of SiC (particulates and whiskers) reinforced X7090 metal matrix composites
  7. Development and assessment of lithium-bearing aluminum P/M alloys (new program)

20. Brown University

Department of Engineering - Physics  
Brown Station

Providence, RI 02912

- Prof. J. Tauc (401) 863-1000
1. Stability of metallic glasses

21. Bureau of Mines (DOI)  
2401 E Street, N.W.  
Washington, DC 20241  
K.W. Mlynarski, Rm. 813 (202) 634-1138  
Programs:  
1. Titanium RST alloys (Albany OR)  
2. Ceramics (Tuscaloosa AL)
22. Cabot Corporation  
Technology Department  
1020 West Park Avenue  
Kokomo, IN 46901  
Christian L. Jeanfils (317) 456-6251  
Anthony J. Hickl (317) 456-6216  
Programs:  
1. Hardfacing by welding: this research program is planned to start in the summer of 1981  
2. Powder atomization techniques, high-solidification-rate techniques for superalloy powders
23. University of California at Los Angeles  
Dept. of Materials Engineering  
405 Hilgard Avenue  
Los Angeles, CA 90024  
Prof. C.N.J. Wagner (213) 825-6265  
Programs:  
1. Structure of liquid and amorphous metallic alloys and structural relaxation of metallic glasses
24. California Institute of Technology  
1201 E. California Blvd.  
Pasadena, CA 91125  
Prof. T.J. Ahrens, Dept. of Physics (213) 795-6811  
Prof. T. Vreeland, Jr. Dept. of  
Matls Science  
Dr. J. Mayer, Dept. of Electrical Engr.  
Dr. W.L. Johnson, Div. of Engr.  
& Applied Science  
Programs:  
1. Dynamic compaction of iron and steel powders  
2. Powder production via ion beam heating  
3. Synthesis, structure, and properties of amorphous alloys
25. Carnegie-Mellon University  
Department of Metallurgical Engr. and Materials Science  
5000 Forbes Avenue  
Pittsburgh, PA 15213  
Prof. J.C. Williams (412) 578-2704  
Prof. R.G. Sekerka (412) 578-2700  
Prof. F. Prinz, Dept. of Mechanical Engr.

Programs:

1. Kinetics, morphology, and thermodynamics of solid-liquid transition
2. Properties and microstructure of rapidly solidified Ni-Mo-Al-X alloys
3. Powder metallurgy aluminum alloys for high temperature

26. Carpenter Technology Corporation

P.O. Box 662

Reading, PA 19603

Donald R. Muzyka, Division Vice

President-Technical (215) 371-2657

Gunvant N. Maniar, General Manager  
of R&D Laboratories

(215) 371-2783

Programs:

1. Inert gas atomized specialty materials, superalloys, tool steels, stainless and other high alloys
2. Water atomized P/M pilot plant
3. Direct compaction of water-atomized elemental and alloy P/M
4. Compaction technology as it relates intermediate shapes from P/M

27. Clarkson College of Technology

Department of Physics

Potsdam, NY 13676

Prof. S. Arajs (315) 268-2396

Prof. R. Caton (315) 268-2350

Programs:

1. Electric and magnetic properties of glassy and amorphous materials.
2. Effects of radiation (neutrons, protons, electrons,) on glassy materials.
3. Preparation of glassy materials by spinning method.
4. Crystallization phenomena in glassy structures.

28. Climax Molybdenum Company

Division of AMAX Inc.

1600 Huron Parkway

Ann Arbor, MI 48106

Dr. M. Semchyshen (313) 761-2300

Programs:

1. Research in RST

29. Columbia University

918 Mudd Building

New York, NY 10027

Prof. John K. Tien (212) 280-5192

Programs:

1. Comparative study of RSR superalloy powders and consolidated structures and argon atomized powders and structures

30. University of Connecticut  
Metallurgy Department  
Storrs, CT 06268  
Prof. Peter R. Strutt (203) 486-3514  
Brian G. Lewis (203) 486-4620  
Mohan Kurup  
Jing-gu-Zhang  
Bernard H. Kear (Adjunct Prof. at Univ. of Conn.).  
Programs:  
1. Electron Beam/Laser Glazing of Iron-Base Materials (P.R. Strutt, B.G. Lewis, and Mohan Kurup). This study is involved with the fundamental aspects of rapidly solidified tool steels and iron-base cemented carbide materials, including microstructural characterization and the microstructural dependence on process parameters such as power density and beam velocity. Another aspect involves wear and fatigue fretting studies of glazed surfaces produced by a specially developed programmable beam deflection system.  
2. Electron Microscopy of Electron Beam Glazed Alloys (Jing-gu-Zhang). A basic investigation of the complex microstructures in rapidly solidified steels using quantitative diffraction contrast analysis.

31. Cornell University  
Materials Science Center  
Clark Hall  
Ithaca, NY 14853  
H.H. Johnson (607) 256-4272  
D.G. Ast  
N.W. Ashcroft  
Programs:  
1. Mechanical properties of amorphous metals  
2. Theoretical studies of ordered and disordered systems

32. Crucible Research Center  
Colt Industries, Inc.  
Route 60 and Parkway West  
Robinson Twp.,  
Pittsburgh, PA 15205  
Mailing Address: P.O. Box 88, Pittsburgh, PA 15230  
E.J. Dulis (412) 923-2955  
J.H. Moll  
Programs:  
1. HIP of large Ti P/M shapes  
2. Dual property integral turbine wheel  
3. Production of advanced turbine engine components to near-net shapes by hot isostatic pressing superalloy powder  
4. Long-life engine discs from RSR powder  
5. Powder cleanliness improvement program

6. ER welded HIP nacelle frame
  7. New and improved cutting and forming tool steels by CPM process
  8. New method for making high-quality Ti alloy powder
  9. Improved containerization methods for making P/M shapes
33. University of Delaware  
Department of Physics  
Newark, DE 19711  
Dr. D.G. Onn (302) 738-2680  
Programs:  
1. Radiation effects in amorphous metallic alloys
34. Drexel University  
Department of Materials Engineering  
32nd and Chestnut Streets  
Philadelphia, PA 19104  
Prof. Alan Lawley (215) 895-2326  
1. High-chromium white irons from rapidly solidified powders - structure vs properties  
2. Tool steels from rapidly solidified powders - structure vs properties  
3. High-strength aluminum alloys from rapidly solidified powders-fatigue response  
4. Elevated-temperature aluminum alloys from rapidly solidified powders (planned)
35. DWA Composite Specialties, Inc.  
21133 Superior Street  
Chatsworth, CA 91311  
Dr. W.C. Harrigan (213) 998-1504  
J.F. Dolowy, Jr.  
B.A. Webb  
E.C. Supan  
Programs:  
1. Processing to stiff, strong-particulate-reinforced aluminum materials with isotropic properties  
2. Developing constituent interaction models for RST light metals reinforced with ceramic particulate material  
3. Processing development to produce forged and extruded structures from particulate-reinforced RST forms of aluminum and magnesium
36. Exxon Enterprises - Materials Division  
P.O. Drawer H, Old Buncombe at Poplar  
Greer, SC 29651  
J.O. Pickens (803) 877-0123  
P.E. Hood  
1. RSR/Silicon carbide whisker composites

37. University of Florida  
Department of Materials Science and Engineering  
Gainesville, FL 52611  
Dr. R.W. Gould (904) 392-1457  
1. Rapidly solidified Ni-Al-Mo alloy research.  
characterization
38. Garrett Turbine Engine Company  
A Division of The Garrett Corporation  
111 South 34 Street, P.O. Box 5217  
Phoenix, AZ 85010  
Dr. T.E. Strangman (602) 267-4399  
P.P. Millan, Jr. (602) 267-4129  
Programs:  
1. Advanced turbine airfoil alloys  
2. High-temperature-capability disk alloys  
3. High-temperature-capability aluminum alloys
39. General Electric Company  
Aircraft Engine Group  
Material and Process Technology Laboratory  
Evendale Plant  
I-75 & Newmann Way  
Cincinnati, OH 45215  
A.M. Johnson (513) 243-5085  
Programs:  
1. Long life engine disks from gas-atomized powders  
2. Melt spinning  
3. Rapid solidification plasma deposition
40. General Electric Corporate Research and Development  
Schenectady, NY 12301  
Dr. H.H. Liebermann (518) 385-8072  
Dr. R.G. Rowe (518) 385-8387  
Dr. L.A. Johnson (518) 385-8181  
Programs:  
1. Melt-spinning of Ni-Base superalloys  
2. Processing and properties of amorphous alloys for electromagnetic applications.
41. Georgia Institute of Technology  
Fracture and Fatigue Research Laboratory  
School of Chemical Engineering  
Atlanta, GA 30332  
Dr. Edgar A. Starke, Jr. (404) 894-2880  
Dr. Thomas H. Sanders (404) 894-2816  
Programs:  
1. Advanced aluminum alloys from rapidly solidified powders

42. Gould Laboratories Materials Research  
Gould Inc.,  
540 East 105th Street  
Cleveland, OH 44108  
Dr. David H. Po (216) 371-8718  
Programs:  
1. Direct rolling of high-strength aluminum powder metal strip  
2. Evaluation of rapidly solidified aluminum alloy powders for high-temperature applications  
3. Manufacturing techniques for high-strength aluminum near-net-shapes  
4. Manufacturing techniques for SiC/Al composite  
5. Microstructural analysis of rapidly solidified aluminum alloy powders
43. GTE Laboratories Incorporated  
Precision Materials Technology Center  
40 Sylvan Road  
Waltham, MA 02254  
Dr. R.P.I. Adler (617) 890-8460  
Dr. S.C. Hsu (617) 890-8460  
Dr. D.M. Koffman (617) 890-8460  
Programs:  
1. Rapid Solidification Process Development and Implementation Studies  
a. Analytical Process Characterization  
    1) Heat and mass transfer modeling  
    2) Process parameter characterization  
b. Process Development/Industrial Upscaling for:  
    1) Chill block melt spinning  
    2) Double roller melt spinning  
    3) Melt extraction (crucible and pendant drop)  
    4) Powder making  
    5) Composite and laminate production  
c. Materials Evaluation of Amorphous, Microcrystalline, and Crystalline products  
    1) Characterization of as-formed products  
    2) Post forming thermo-mechanical treatments of metastable products
44. Harvard University  
Division of Engineering and Applied Physics  
Cambridge, MA 01238  
Prof. D. Turnbull (617) 868-7600  
Programs:  
1. Formation of metallic glasses
45. University of Hawaii at Manoa  
2500 Campus Road  
Honolulu, HI 96822

- B.E. Liebert  
Programs:  
1. Basic research in RST
46. Homogeneous Metals, Inc.  
P.O. Box 294  
Clayville, NY 13322  
Charles W. Fox (315) 839-5421  
Programs:  
1. Development of atomization technique  
2. Direct consolidation of powders
47. Howmet Turbine Components Corp.  
475 Steamboat Road  
Greenwich, CT 06830  
Wm. R. Freeman, Jr. (203) 661-7218  
Louis L. Dardi (616) 894-7562  
Programs:  
1. Development of rapid solidification processing equipment  
2. Alloy development
48. University of Illinois, Urbana-Champaign  
College of Engineering  
Urbana, IL 61801  
Prof. D.C. Drucker (217) 333-1000  
R.D. Field  
Programs:  
1. Structure of rapidly-solidified superalloy powders
49. Institute for Defense Analyses  
400 Army-Navy Drive  
Arlington, VA 22202  
T.F. Kearns (703) 558-1643  
Programs:  
1. An assessment of rapid solidification technology and its Department of Defense applications.
50. International Business Machines (IBM)  
T.J. Watson Research Center  
Yorktown Heights, NY 10598  
G.S. Cargill III  
Programs:  
1. Structure of amorphous metals
51. Johns Hopkins University  
Applied Physics Laboratory  
Johns Hopkins Road  
Laurel, MD 20810

- Dr. T.O. Poehler (301) 953-7100 x 2043  
K. Moorjani (301) 953-7100 x 7036
- Programs:  
1. Amorphous iron borides
52. Johns Hopkins University  
Materials Science Department  
Baltimore, MD 21218  
Prof. R.B. Pond, Sr. (301) 338-7125
- Programs:  
1. Chill block melt spinning  
2. Puddle melt extraction
53. Kaiser Aluminum & Chemical Corporation  
Center for Technology  
P.O. Box 877  
Pleasanton, CA 94566  
T.R. Pritchett (415) 462-1122  
I. Broverman  
J.L. Dassel  
S.G. Roberts
- Programs:  
1. Aluminum alloy powder metallurgy  
2. Aluminum alloy solidification kinetics and structures
54. Lawrence Livermore National Laboratory  
P.O. Box 808  
Livermore, CA 94550  
G. Dorrough (415) 422-4892  
B. Holt  
C. Cline
- Programs:  
1. Synthesis of amorphous, metastable crystalline, or supersaturated solid solutions of beryllium-containing alloys by rapid-quench techniques.
55. Lockheed California Company  
P.O. Box 551  
Burbank, CA 91520  
R.F. Simenz (213) 847-3647  
Dept. Manager, Materials & Processes  
Lockheed California Company, Burbank, CA.
- Programs:  
1. System study, transport aircraft  
2. Supersonic cruise aircraft research  
3. High-temperature aluminum development  
4. Manufacturing methods for aluminum PM precision forgings  
5. Aluminum powder metallurgy alloys for superplastic forming

56. Lockheed-Georgia Company  
Dept. 72-77 Zone 450  
Marietta, GA 30063  
Dr. Walter S. Cremens (404) 424-4694  
William F. Bates, Jr. (404) 424-3902  
Programs:  
1. Evaluation of aluminum alloys and steels made by powder metallurgy from rapidly solidified powders.
57. Lockheed Palo Alto Research Laboratory  
Lockheed Missiles and Space Company  
3251 Hanover Street  
Palo Alto, CA 94304  
R.E. Lewis (413) 493-4411 x 45743  
I.G. Palmer (415) 493-4411 x 45028  
Programs:  
1. Development of advanced aluminum alloys from rapidly solidified powders for aerospace structural applications  
2. Advanced aluminum alloys from rapidly solidified particulate
58. Los Alamos National Laboratory  
Chemistry-Materials Science Division  
Los Alamos, NM 87545  
Dr. J.R. Cost (505) 667-2248  
Dr. R.O. Elliott (505) 667-4706  
Programs:  
1. Activation energies for atomic motion in Metglas alloys  
2. Irradiation-enhanced diffusion in metallic glasses  
3. Diffusion of hydrogen and/or helium in metallic glasses  
4. Effect of fission-fragment irradiation on SRO in a metallic glass  
5. Irradiation-induced amorphisation and development of prediction criteria for the process
59. M-Structures, Inc.  
Box 564, 299 Ridge Road  
Westminster, MD 21157  
Robert B. Pond, Jr. (301) 876-6801  
Programs:  
1. Vacuum die-cast alloy shaped charge liners
60. Marko Materials, Inc.  
144 Rangeview Road  
North Billerica, MA 01862  
Dr. Ranjan Ray (617) 663-2210  
Programs:  
1. Scale-up of a rapid solidification powder process  
2. Development of RSP iron-base alloys with high strength and/or high wear, oxidation- and/or corrosion-resistant properties

- 3. Development of RSP aluminum alloys for high-strength applications at elevated temperature
  - 4. Development of RSP copper-base alloys with high strength and corrosion resistance.
61. Martin Marietta Laboratories  
 1450 South Rolling Road  
 Baltimore, MD 21227  
 Dr. Joseph R. Pickens (301) 247-0700 x 373  
 Programs:  
 1. Stress-corrosion cracking and liquid metal embrittlement in rapidly solidified alloy, CT 91 (7091)  
 2. Stress corrosion in rapidly solidified alloys CT 91 and MR 61, compared with mechanically alloyed material, IN 9051.
62. MARVALAUD, INC.  
 P.O. Box 331 (301) 876-2477  
 Westminster, MD 21157  
 Prof. Robert B. Pond, Sr.  
 John Winter  
 Programs:  
 1. Chill block and free flight melt spinning process development  
 2. Puddle melt extraction process development  
 3. Development of processes producing rapidly solidified disintegrated metals and alloys  
 4. Investigation and exploitation of metal and alloy properties resulting from the operation of the above processes
63. Massachusetts Institute of Technology  
 77 Massachusetts Avenue (616) 253-3324  
 Cambridge, MA 02139  
 Prof. Morris Cohen (616) 253-3233(4)  
 Prof. Merton C. Flemings (616) 253-5637  
 Prof. Nicholas J. Grant (616) 253-4697  
 Prof. Ronald Latanision (616) 253-3322  
 Prof. Roy Kaplow (616) 253-7172  
 Prof. Frederick J. McGarry (616) 253-3236  
 Prof. Julian Szekely (616) 253-6933  
 Prof. John B. Vander Sande (616) 253-3239  
 Prof. Gregory Yurek (616) 253-3328  
 Prof. Kenneth Russell (616) 253-3328  
 Programs:  
 1. Deformation and fracture behavior of rapidly solidified carbide dispersion strengthened superalloys at high temperatures (Grant)  
 2. Crack initiation and growth in high-temperature superalloys under high-temperature creep conditions (Grant)

3. Superplastic deformation of mixed alpha-gamma stainless steels prepared from rapidly quenched particulates (Grant)
4. The mechanical behavior of metallic glasses (Grant)
5. The role of alloying on the stability and properties of Pd-Si glasses (Grant)
6. The properties of Ni<sub>60</sub>-Nb<sub>40</sub> glasses (Grant)
7. Structure and properties of lithium-alloyed 2024 and Al-Mg-Li/type aluminum alloys prepared from rapidly solidified particulates (Grant)
8. The structure and properties of aluminum alloy 2020 + Li produced by rapid solidification from the melt (Grant)
9. The potential for oxide-dispersed, rapidly solidified, fine-grained ultrasonically atomized aluminum alloys for high-temperature service (Grant)
10. Oxide-dispersed type 316 stainless steels produced from rapidly quenched fine powders (Grant)
11. Type 316 stainless steels prepared from rapidly quenched particulates as first wall fusion reactor materials (Grant)
12. The structure and properties of rapidly solidified, titanium-modified 316 stainless steel first wall fusion reactor alloy (Grant)
13. High-strength, high-temperature, high-thermal-conductivity copper-base alloys (Grant)
14. The structure and properties of high-thermal-conductivity, high-temperature, high-strength, copper-based alloys produced by rapid solidification (Grant)
15. The crystallization and consolidation of high glass transition temperature metallic glasses (Grant)
16. Preliminary work on ion irradiation of first wall materials (Russell)
17. Rapidly solidified Ti-modified 316 stainless steels for irradiation environments (Grant, Vander Sande)
18. Study of void nucleation under irradiation with continuous helium generation (Russell)
19. Chemical stability of metallic glasses (Latanision)
20. Hydrogen permeation and embrittlement in metallic glasses (Latanision)
21. Structure of amorphous and semi-crystalline polymers (Vander Sande)
22. Oxidation resistance of rapidly solidified austenitic steels (Yurek)
23. Ultra-rapid solidification (Flemings)
24. Rapid solidification of magnesium (Flemings)
25. Undercooling, structure, and rapid solidification (Flemings)
26. Mathematical modelling of rapid quenching techniques (Szekely)
27. Rapid solidification of thermoplastics (McGarry)

- 28. Crystallization of Fe-B glasses (Kaplow)
  - 29. STEM microanalysis of rapidly solidified steels (Cohen, Vander Sande)
  - 30. Grain growth behavior of rapidly solidified steels (Cohen, Vander Sande)
  - 31. Fracture toughness of rapidly solidified steels (Cohen)
  - 32. Tempering behavior of rapidly solidified martensitic steels (Cohen, Vander Sande)
  - 33. Physical metallurgy of RSP microalloyed steels (Vander Sande, Cohen)
  - 34. Oxidation resistance of RSP austenitic steels (Yurek)
64. McDonnell-Douglas Research Laboratories  
 P.O. Box 512  
 St. Louis, MO 63166  
 D.P. Ames (314) 232-3254  
 Programs:  
 1. Evaluation of RST alloys
65. McGill University  
 Ernest Rutherford Physics Building  
 3600 University Street  
 Montreal, PQ  
 Canada, H3A 2T8  
 Prof. J.O. Strom-Olsen (514) 392-4419  
 Prof. W.B. Muir (514) 392-4786  
 Prof. R. Harris (514) 392-4407  
 Prof. M. Zuckermann (514) 392-4787  
 Dr. Z. Altounian (514) 392-4412  
 Programs:  
 1. Stability of melt-spun amorphous metals.  
 2. Electron transport properties of amorphous metals,  
    especially at low temperatures  
 3. Magnetic properties (including Mossbauer effect) of  
    amorphous magnetic alloys  
 4. Structural modelling of amorphous systems
66. Michigan Technological University  
 Department of Metallurgical Engineering  
 Houghton, MI 49931  
 Prof. T.H. Courtney (906) 487-2036  
 Prof. R.W. Heckel (906) 487-2010  
 Prof. D.A. Koss (906) 487-2170  
 Prof. D.W. Smith (906) 487-2037  
 Programs:  
 1. Structure-property relationships in powder-fabricated  
    metals and alloys (several programs)  
 2. Powder fabrication of alloys via homogenization pro-  
    cessing (several alloy systems)

3. Fatigue and fracture phenomena in high-performance powder-fabricated alloys (to begin in the near future)
  4. High-temperature oxidation and oxidation-resistant coatings (superalloys)
67. NASA Langley Research Center  
Materials Division  
Structures Directorate  
Hampton, VA 23665  
B. Lisgor (804) 827-1110 x 3386  
Programs:
  1. Powder metallurgy aluminum alloys for structural application
  2. Thermo-mechanical processing of PM aluminum alloys
68. NASA Lewis Research Center  
Materials Division  
Cleveland, OH 44135  
H.B. Probst (216) 433-4000 x 6392  
Programs:
  1. Physical metallurgy of innovative alloy systems
  2. Evaluation of RST alloys in iron- and nickel-based systems
69. National Bureau of Standards (DOC)  
Materials Bldg.  
Washington, DC 20234  
Dr. J. Wachtman, Jr. Rm. B 308 (301) 921-2981  
Dr. R. R. Mehrabian Rm. B 266 (301) 921-2811  
Dr. J.W. Cahn Rm. A 153  
Programs:
  1. Production of well-characterized powders
  2. Characterization of rapidly solidified powders
  3. Phase diagrams of interest in RST
  4. Thermodynamics of solidification
70. Naval Air Development Center  
Aero Materials Laboratory (6063)  
Jacksonville and Street Roads  
Warminster, PA 18974  
Dr. G.J. London (215) 441-2808  
R.G. Mahorter (215) 441-2809  
Programs:
  1. Evaluation of RST alloys
71. Naval Research Laboratory  
4555 Overlook Avenue, S.W.  
Washington, DC 20375  
Dr. B. Rath (Code 6490) (202) 767-2465  
Programs:
  1. Acoustic damping alloys
  2. Wear-, corrosion-, erosion-resistant alloys

3. Superconducting composites
72. David Taylor Naval Ship Research & Development Center  
Ship Materials Engineering Department  
Annapolis, MD 21402  
J.R. Belt (301) 267-2635  
J.R. Crisci (301) 267-2462  
B. Hammond (301) 267-3655  
Programs:  
1. Rapidly solidified alloys for corrosion resistance  
of machinery alloys
73. Naval Surface Weapons Center  
R-32, Metallic Materials Branch  
White Oak, MD 20910  
A.P. Divecha (202) 394-2019  
H. Dejarnette  
Dr. L. Kabacoff  
S.D. Karmakar  
Programs:  
1. Al-Li ingots via rapid crystallization under pressure  
2. Al-Mg ingots via rapid crystallization under pressure  
3. SiC whisker and SiC particle-reinforced aluminum alloy  
flakes and sheets via rapid-solidification and defor-  
mation processing  
4. Amorphous ribbons via rapid solidification for magneto-  
strictive alloys
74. North Carolina State University  
Raleigh, NC 27650  
R.B. Benson, Jr. (919) 737-2377  
P.A. Parrish  
1. Enhanced corrosion resistance of metal surfaces by ion  
treatment
75. Northeastern University  
Institute of Chemical Analysis  
360 Huntington Avenue  
Boston, MA 02115  
Prof. B.C. Giessen (617) 437-2827  
Programs:  
1. Preparation and characterization of new metallic glasses  
2. Production and consolidation of experimental quantities  
of RST powders
76. Northrop Corporation  
Aircraft Division (Dept. 3871/62)  
3901 West Broadway  
Hawthorne, CA 90250  
Dr. G.R. Chanani (213) 970-4963  
I. Telesman

Programs:

1. Development and processing of aluminum-lithium-base<sup>3</sup> alloys using both rapid-solidification and ingot technology
2. Investigation of high-strength fatigue resistant P/M 7XXX and 2XXX aluminum alloys
3. Investigation of improved methods for consolidating rapidly solidified aluminum alloy powders
4. High-strength P/M aluminum mill products
5. Manufacturing process for the hot isostatic pressing of large titanium P/M shapes

77. Northwest Technical Industries, Inc.

547 Diamond Point Road  
Sequim, WA 93882

Joseph R. Munn  
Alan W. Hare

(206) 683-4167

Programs:

1. Explosive compaction of rapidly solidified elemental and alloy (steel and aluminum) powders

78. Norton Company

Industrial Ceramics Division  
1 New Bond Street  
Worcester, MA 01606

M.L. Torti  
Research Manager

(617) 853-1000 x2092

Programs:

1. Technology monitoring in ceramics systems

79. Nuclear Metals Inc.

2229 Main Street  
Concord, MA 01742

P. Loewenstein  
Vice President & Technical Director  
P.R. Roberts  
Engineering Manager for Specialty Powders

(617) 369-5410

Programs:

1. Production of powders of most metals and alloys by the rotating electrode process
2. Consolidation of powders by extrusion

80. Oak Ridge National Laboratory (DOE)

Metals and Ceramics Division

P.O. Box X  
Oak Ridge, TN 37830  
J.R. Weir, Jr.  
C.C. Koch  
A. Das Gupta  
D.S. Easton  
D.M. Kroeger

(615) 574-4065

- Programs:
1. Amorphous superconductors
  2. Stability of binary and ternary metallic glasses
  3. Preparation of amorphous materials by arc-hammer, melt spinning, and electron-beam vapor deposition
81. Oak Ridge National Laboratory  
Solid State Division,  
P.O. Box X  
Oak Ridge, TN 37830  
C.W. White (615) 574-6295  
R.R. Appleton (615) 574-6283
- Programs:
1. Pulsed laser annealing of ion-implanted materials
  2. Non-equilibrium crystal growth phenomena
  3. Ultra-rapid heating and cooling using Q-switched and mode-locked laser sources
  4. Formation of supersaturated solid solutions by ion implantation and laser annealing
  5. Metastable surface properties resulting from rapid solidification
82. Ohio State University  
Metallurgical Engineering Department  
Columbus, OH 43220  
Prof. G.W. Powell (614) 422-6608  
Prof. J.P. Hirth
- Programs:
1. Mechanical properties of rapidly solidified powders of Fe-Al-Si alloys after compaction and extrusion
  2. Oxidation resistance of rapidly solidified powders of Fe-Al-Si alloys after compaction and extrusion
83. Oregon Graduate Center  
Department of Materials Science  
19600 N.W. Walker Road  
Beaverton, OR 97005  
Dr. W.E. Wood (503) 645-1121
- Programs:
1. Laser alloying of Fe surfaces
  2. Analysis of microstructure and strengthening mechanisms
84. University of Pennsylvania  
Department of Metallurgy  
Philadelphia, PA 19104  
Prof. T. Egami (215) 243-5000  
Prof. W.R. Graham
- Programs:
1. Research on RST alloys

85. The Pennsylvania State University  
Materials Research Laboratory  
University Park, PA 16802  
R. Messier (814) 865-3704  
N.H. Macmillan (814) 863-0190  
R. Roy (814) 865-3421  
S.V. Krishnaswamy (814) 865-3704  
Programs:  
1. Explosive crystallization of tetrahedrally bonded amorphous semi-conductor films  
2. Laser treatment of ceramics  
3. Plasma-sprayed layers
86. Phrasor Scientific, Inc.  
1536 Highland Avenue  
Duarte, CA 91010  
J.F. Mahoney (213) 357-3201  
Dr. Julius Perel  
1. Development of a table top fine powder generator and film coater for materials science investigations
87. University of Pittsburgh  
Department of Metallurgy and Materials  
Pittsburgh, PA 15260  
Prof. F.S. Pettit (412) 624-4141  
Programs:  
1. Basic research in rapidly solidified alloys
88. Polytechnic Institute of New York  
Microwave Research Institute  
Route 110  
Farmingdale, NY 11735  
Prof. W.T. Walter (516) 694-5500  
Prof. M. Newstein  
Dr. N. Solimene  
Programs:  
1. Reflectance changes of metals and semiconductors during laser irradiation  
2. Laser interaction with metallic surfaces  
3. Optical properties of metals during laser irradiation  
4. High-power electromagnetic wave interaction with matter  
5. Laser annealing of semiconductors
89. Pratt and Whitney Aircraft Group  
Commercial Products Division  
400 Main Street  
East Harford, CT 06108  
Dr. M. Blackburn (203) 565-3185  
C.C. Law (203) 344-5092  
D.F. Paulonis (203) 565-4667

Programs:

1. Evaluation of RST alloys
2. Advanced high-temperature aluminum alloys development

90. Pratt and Whitney Aircraft Group

Government Products Division

P.O. Box 2691

West Palm Beach, FL 33402

Arthur R. Cox

(305) 840-3234

Programs:

1. Solidification theory
2. Process development for rapid solidification
3. Metal working relationship to rapid solidification powders
4. Rapid solidification as a means to reduce strategic element usage
5. Rapid solidification alloys for jet engine turbine blades and vanes
6. Rapid solidification alloys for jet engine turbine discs
7. Rapid solidification of alloys for jet engine bearings
8. Rapid solidification aluminum alloy development
9. Rapid solidification high strength steel development
10. Rapid solidification corrosion-resistant steel development
11. Rapid solidification development for special-purpose steels and Ni alloys
12. Rapid solidification effects on corrosion of super-alloys

91. Purdue University

Department of Materials Engineering

Lafayette, IN 47907

Prof. J. Radavich

(317) 749-8111

Programs:

1. Research in RST alloys

92. Rensselaer Polytechnic Institute

Materials Engineering Department

Troy, NY 12181

Prof. M.E. Glicksman

(518) 270-6372

Programs:

1. Solute redistribution during rapid solidification: fundamental studies of how rapid solidification influences microsegregation and homogeneity
2. Dendritic growth--kinetics and micromorphology: studies relating dendritic structures to processing variables--especially cooling rate, supercooling, branch spacing, growth speed--to materials parameters and alloy characteristics

93. Revere Research, Inc.  
P.O. Box 1352  
Edison, NJ  
Dr. S. Shapiro (201) 225-2000  
Programs:  
1. High-pressure extrusion of powders
94. Reynolds Metals Company  
Metallurgical Research Division  
P.O. Box 27003  
Richmond, VA 23226  
B.F. Holcombe, Jr. (804) 788-7563  
DOD Contracts  
Dr. D.S. Thompson (804) 788-7404  
Director Dept. Metallurgy  
O.R. (Duke) Singleton (804) 788-7462  
Program Manager, #1 below  
Programs:  
1. Manufacturing technology: high-strength, powder metallurgy mill products  
2. Dispersion hardened P/M alloys  
3. Aluminum matrix, P/M composites  
4. Improved P/M billet production techniques
95. University of Rochester  
Department of Mechanical and Aerospace Sciences  
Rochester, NY 14627  
Dr. J.C. Li (716) 275-4038  
Programs:  
1. Mechanical properties of amorphous metals
96. Rocketdyne  
Division of Rockwell International  
6633 Canoga Avenue Mail Stop DA-92  
Canoga Park, CA 91304  
C.M. Moss (213) 884-3527  
J.R. Lewis (213) 884-3527  
Programs:  
1. Injection-molding and sintering of rapidly solidified nickel-base superalloy powders
97. Rockwell International  
Rocky Flats Plant  
P.O. Box 464  
Golden, CO 80401  
R.R. Corle (303) 497-2577  
Ms. C.L. Ferrera (303) 497-2148  
Programs:  
1. Rapid solidification of beryllium

98. Rockwell International Science Center  
1049 Camino Dos Rios  
Thousand Oaks, CA 91360  
M. Mitchell  
D. Gnanamuthu (805) 498-4545 x 343  
Programs:  
1. Properties of materials produced by rapid solidification technology  
2. Laser processing of materials using rapid solidification technology
99. SCM Corporation  
11000 Cedar Avenue  
Cleveland, OH 44106  
C.I.Whitman/Director R&D (216) 344-8446  
E. Klar/Manager-Particle Tech (216) 344-8496  
K. Kulkarni/Manager-Ferrous Full (216) 344-8445  
Dense Materials  
Programs:  
1. Metallurgical structure control in atomization and consolidation
100. Sandia National Laboratories  
P.O. Box 5800  
Albuquerque, NM 87185  
S. Thomas Picraux (505) 844-7681  
Paul S. Peercy (505) 844-6076  
Programs:  
1. Pulsed electron beam annealing of metals and semiconductors  
2. Swept line electron beam annealing of metals and semiconductors  
3. Pulsed laser annealing of metals and semiconductors
101. Sandia National Laboratories  
Materials Development Division 8312  
Livermore, CA 94550  
Dr. J.E. Smugeresky (415) 422-2910 x2476  
Programs:  
1. Evaluation of rapid solidification powder-making processes for JRK-75 and A-286  
2. Effect of powder characteristics and consolidation parameters on the microstructure and properties of rapidly solidified steels  
3. Characteristics of gas atomized Nitronic 40 stainless steel as a function of atomizing gas  
4. Effect of composition and powder-making process on the properties of rapidly solidified powder processed maraging steels  
5. Evaluation of rapid solidification processes for the production of powders of Incoloy 903

6. Hot isostatic pressing of rapidly solidified HP-9-4-20  
steel powders
102. Sikorsky Aircraft  
Transmission System Section  
Stratford, CT 06602  
J.G. Kish (203) 386-5391  
Programs:  
1. High-performance gears
103. University of Southern California  
3551 University Avenue  
Los Angeles, CA 90007  
Prof. S.M. Copley (213) 741-6225  
Dept. of Materials Science  
Dr. M. Bass  
Dept. of Physics (213) 741-7994  
Programs:  
1. Solidification of metallic melts produced by laser  
irradiation
104. Special Metals Corporation  
Middle Settlement Road  
New Hartford, NY 13413  
J.W. Pridgeon (315) 798-2930  
L.A. Jackman  
W.J. Boesch  
Programs:  
1. Fine-grain ingots by vacuum arc remelting  
2. Development of powder-making processes  
3. Structure of rapidly solidified superalloys
105. Stanford University  
Dept. of Materials-Science and Engineering  
Stanford, CA 94305  
Prof. O.D. Sherby (415) 497-2300  
Programs:  
1. Specialty steels
106. Systems Research Laboratories, Inc.  
2800 Indian Ripple Road  
Dayton, OH 45440  
R.E. Omilor  
Programs:  
1. Characterization of powders and foils
107. University of Toronto  
Dept. of Metallurgy and Materials Science  
Toronto, ON M5S 1A4,  
Canada

- Prof. Y. Waseda (416) 978-3012  
Prof. K.T. Aust
- Programs:
1. Structure of rapidly quenched metals by x-ray and neutron diffraction
  2. Chemical properties such as corrosion behavior of metallic glasses
108. TRW Equipment Group  
TRW Incorporated  
23555 Euclid Avenue  
Cleveland, OH 44117  
John A. Alexander (216) 383-3292
- Programs:
1. Processing evaluation of RST alloys
109. United Technologies Research Center  
Silver Lane  
East Hartford, CT 06108  
Dr. E.R. Thompson (203) 727-7344
- Programs:
1. Laser and layerglaze processing and pertinent alloy development
  2. Dynamic compaction of rapidly solidified alloys
  3. Alloys for rapid solidification processing and consolidation techniques
110. Universal-Cyclops Specialty Steel Division  
Research and Development Department  
Mayer Street  
Bridgeville, PA 15017  
L.W. Lherbier (412) 221-8000 x 300  
W.B. Kent (412) 221-8000 x 343  
J.T. Cordy (412) 221-8000 x 366
- Programs:
1. Rapidly solidified powder via gas atomization
  2. Controlled rate solidification of specialty steel billets
111. Valimet, Inc.  
P.O. Box 6186  
431 Sperry Road  
Stockton, CA 95206  
William K. Fortman, Pres. (209) 982-4870  
Terry S. Ullman, Mgr. Special Alloys
- Programs:
1. Helium-gas-atomized powder production

112. University of Virginia  
Department of Materials Science  
Thornton Hall  
Charlottesville, VA 22901  
Dr. L.B. Johnson, Jr. (804) 924-3264  
Programs:  
1. Dental materials applications
113. Western Electric Engineering Research Center  
Laser Studies Group  
P.O. Box 900  
Princeton, NJ 08540  
Dr. C.W. Draper (609) 639-2527  
Programs:  
1. The use of laser quenching of conventional alloys  
(mostly Cu-based) to produce metastable single-phase  
surfaces  
2. The use of laser surface alloying to produce novel  
compositions in metals  
3. Studies of the damage induced in single crystal metals  
by laser irradiation  
4. Determination of the effects of items 1 through 3 on  
the surface sensitive behavior of metals  
5. Studies of the redistribution of ion implants in metals  
by laser irradiation treatments
114. Westinghouse Electric Corp., R&D Center  
1310 Beulah Road  
Pittsburgh, PA 15235  
Dr. F.E. Werner (412) 256-3556  
Programs:  
1. Evaluation of Allied Corp METGLAS alloys for 60 Hz  
transformers  
2. Basic studies of crystallization and other phenomena
115. Univeristy of Wisconsin-Madison  
Madison, WI 53706  
J.H. Perepezko (608) 263-1678  
Programs:  
1. Solidification of highly undercooled liquid droplets

SECTION II. RESEARCH AND DEVELOPMENT SPONSORS

- 1S Air Force Wright Aeronautical Laboratories  
Flight Dynamics Laboratory  
Wright Patterson AFB  
OH 45433  
F. Boensch (FIBAA) (513) 255-5006  
L.G. Kelly (FIBC) (513) 255-4030
- 2S Air Force Wright Aeronautical Laboratories  
Materials Laboratory  
Wright Patterson AFB  
OH 45433  
Dr. H. Burte (/MLL) (513) 255-5348  
G. Eichelman (/MLLS) (513) 255-3839
- 3S Air Force Wright Aeronautical Laboratories  
Propulsion Laboratory  
Wright Patterson AFB  
OH 45433  
R.E. Supp, (/PO) (513) 255-5334
- 4S Air Force Office of Scientific Research/NF  
Bolling Air Force Base  
Washington, DC 20332  
Dr. A.R. Rosenstein (202) 767-4931
- 5S Army Armament R&D Command  
AARADCOM  
Dover, NJ 07801  
Dr. J. Waldman (201) 328-5111  
Dr. S.J. Cytron (201) 328-5746
- 6S Army Materials and Mechanics Research Center  
Watertown, MA 02172  
Dr. G.H. Bishop, Jr. (617) 923-3436  
Dr. S. Isserow, DSXMP-KA (617) 923-3504
- 7S Army Mobility Equipment R&D Command  
MERADCOM  
Fort Belvoir, VA 22060  
W.F. McGovern (703) 664-5459

- 8S Army Research Office  
P.O. Box 12211  
Research Triangle Park  
NC 27709  
Dr. G. Mayer (919) 549-0641
- 9S Defense Advanced Research Projects Agency  
1400 Wilson Blvd.  
Arlington, VA 22209  
Dr. E. Van Reuth (202) 694-4750  
Lt. Col. L. Jacobson, USAF (202) 694-1346
- 10S Department of Energy  
Division of Materials Sciences  
Washington, DC 20545  
Dr. D. Stevens (ER-13) (303) 353-3427
- 11S Electric Power Research Institute  
3412 Hillview Avenue  
Palo Alto, CA 94304  
E. Norton (415) 855-2282
- 12S Department of Interior  
Bureau of Mines  
Mineral Resources Technology  
Division  
2401 E. Street, N.W.  
Washington, DC 20241  
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